STUDIES IN THE GENUS *ARISTIDA* (GRAMINEAE) OF THE SOUTHEASTERN UNITED STATES. I. SPIKELET VARIATION IN *A. PURPURESCENS*, *A. TENUISPICA*, AND *A. VIRGATA*

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ABSTRACT

Morphologic variation in *Aristida purpurescens*, *A. tenuispica*, and *A. virgata* was assessed by principal components and step-wise discriminant analyses. Although well-defined clusters corresponding to the three taxa were defined by principal component analysis (PCA), extensive morphologic overlap was also evident. Both the PCA and discriminant analyses assigned some spikelets from the same panicle to different taxa. A single morphologic species is suggested.

Key Words: *Aristida*, taxonomy, principal components, discriminant analysis

North American *Aristida* have been classed within three sections: 1) Arthratherum, wherein the lemma is prolonged into a column or beak that disarticulates at its base, just above the lemma; 2) Streptachne, in which the lateral awns are much reduced or obsolete and without an articulated column; and 3) Chaetaria, with well-developed lateral awns and also without an articulated column (Henrard, 1929). Hitchcock (1924) further divided the section Chaetaria into four rather informal groups, Dichotomae, Adscensiones, Divaricatae, and Purpureae, but left about 25 species, mostly from the southeastern United States and West Indies, unplaced as to group.

While working with some of these unplaced species for the Vascular Flora of the Southeastern United States, I experienced difficulty in distinguishing some members of the taxa *A. purpurescens* Poir., *A. tenuispica* Hitchc., and *A. virgata* Trin. These are perennial, cespitose, three-awn grasses with mostly flat blades, narrow contracted panicles, and more-or-less equal glumes. Apparently typical forms of each species were relatively distinct from the others, and from other species as well, but there occurred numerous specimens with confusing and seemingly random combinations of features from the three taxa. This situation prompted the following queries. What is the pattern of morphologic variation within this complex? Are the three taxa delimited by consistent combinations of morphologic features, or does there exist an admixture of features? How extensive is any morphologic overlap among the taxa?

MATERIALS AND METHODS

Over 400 herbarium specimens from throughout the geographic range of the three taxa were examined in a preliminary study of the morphologic features. Of these, 74 specimens were selected that represented well the morphologic variation within the complex, including "extremes" as well as "typical" material. These specimens were assigned to one of four groups: three groups contained typical *purpurescens, tenuispica,* or *virgata* based upon conformity with the original descriptions and descriptions of the types in Henrard (1932); the fourth group was composed of unassigned specimens that were difficult to identify or exhibited unusual character combinations. Each of the three typical groups contained 16 operational taxonomic units (OTUs), one OTU from each of 16 specimens. The unassigned group contained 52 OTUs, representing two OTUs (scorings) from each of 26 specimens. The duplicate scoring of each of the unassigned specimens would give some indiction of variability within a single plant. A total of 100 OTUs was used in the analysis.

Following the survey of all herbarium specimens, and after consulting the major reference works dealing with this group of *Aristida,* 12 spikelet features were selected for analysis. They were number of nerves on glume I, lengths of glumes I and II, lemma length, callus length, cnetral and lateral awn lengths, central and lateral awn angles of divergence, and awn contortion. For each of the three typical groups of specimens, measurements were taken from a well-formed spikelet in the upper ¼ of the panicle. For the unassigned group, with 2 OTUs per specimen, measurements were taken from spikelets at both ends of the central ⅓ of the panicle.

Analysis was by principal components (PCA) using standardized data and by step-wise discriminant analysis (SDA) from the BMDP Statistical Software package (Dixon, 1981). For the SDA, the typical groups were used to establish the discriminant equation, and the members of the unassigned group were then given a phenetic identification to one of the three groups based on this equation.

RESULTS AND DISCUSSION

Principal components analysis resulted in a fairly clear distinction of the three typical groups of specimens (Figure 1). This, of course, was the result of the a priori selection of morphologically separable

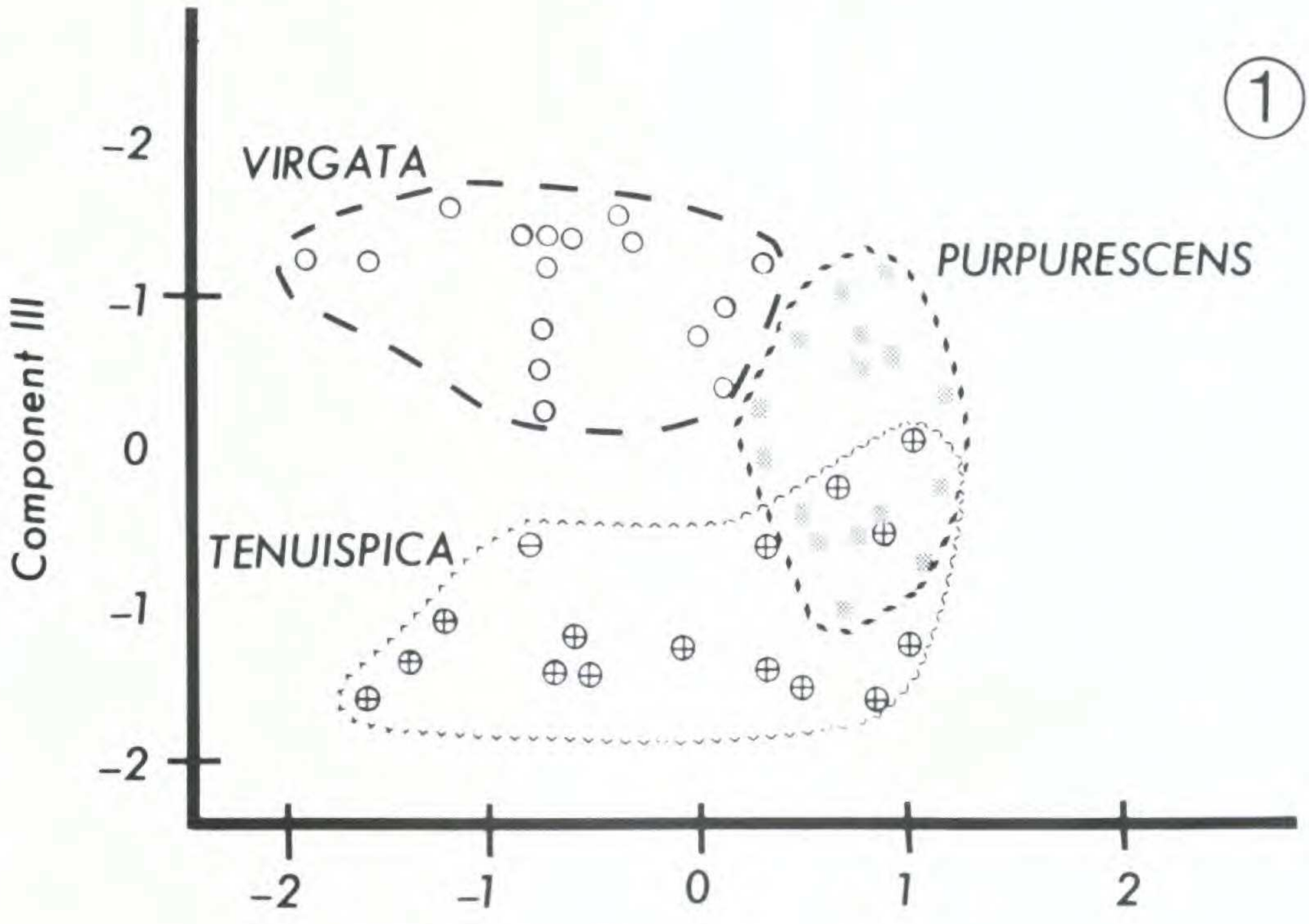

Figure 1. PCA of only the typical groups.

specimens. Greatest resolution was found along axes I and III, reflecting distinctions in glume and lemma lengths (strongly weighted on axis I) and lateral awn angle, central awn width, and awn contortion (strongly weighted on axis III). Axis II reflected a strong weighting with awn length, but did not distinguish the taxa. The first three axes accounted for 54% of the variation; axes I and III for 27% and 12%, respectively. Relative to the other groups, the *purpurescens* entity was characterized by long lemmas and glumes, the first glume longer than the second (inverse), equal awn widths, and equal divergence of the awns with little or no contortion. Typical *virgata* possessed a wide central awn reflexed or divergent between the two erect lateral awns. Typical *tenuispica* had markedly contorted awns with nearly equal divergence, and subequal glumes.

Of note was the phenetic overlap of the typical *purpurescens* and *tenuispica* groups. Specimens within the zone of overlap were rechecked for proper identification: they did seem to fit well the morphologic "concept" of *purpurescens* or *tenuispica,* although differences in awn contortion were less pronounced than among the other specimens.

There were few high correlations of features. Correlations greater than ±0.50 were glume I and II lengths, glume and lemma lengths, central and lateral awn lengths, and awn contortion and lateral awn angle. These were all less than ±0.80, however. The number of nerves on the first glume, callus length, and central awn angle all lacked any meaningful correlation with any other features, and seemed to vary randomly.

Upon addition of the unassigned OTUs to the PCA grid, distinctions between the three taxa are blurred (Figure 2). Identification of these OTUs to *purpurescens, tenuispica,* or *virgata* was by SDA. Of the 26 pairs of OTUs in the unassigned group, 12 were congruous, that is, both OTUs from each pair were assigned to the same taxon by the SDA and fell roughly within that cluster on the PCA grid. However, 14 pairs of OTUs were incongruous, with the OTUs from each pair being assigned to different taxa by the SDA and with generally a corresponding placement by PCA. These incongruous pairs are linked by a solid line in Figure 2. The phenetic similarities of the three taxa are circular, with only slightly more

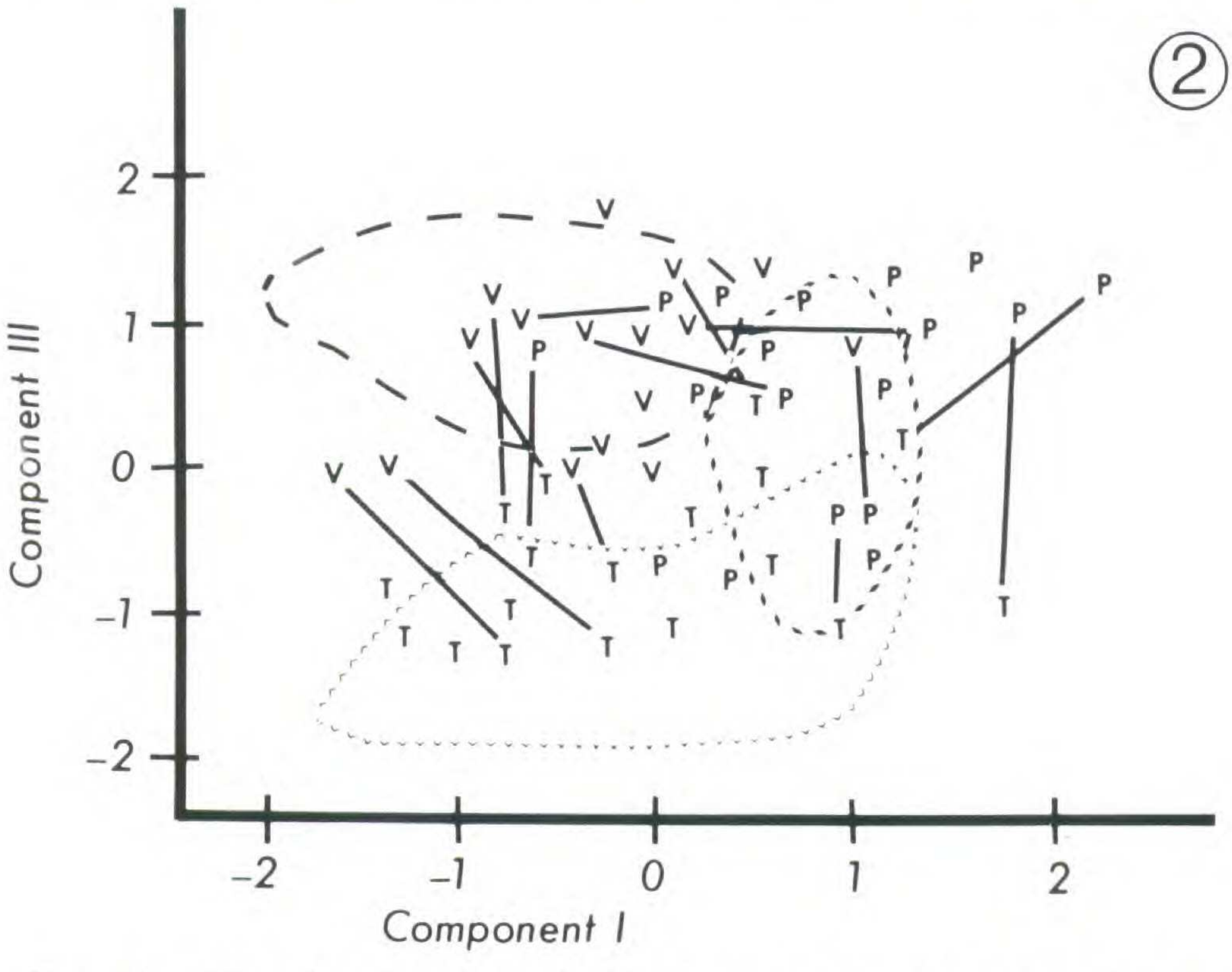

Figure 2. PCA of the unassigned OTUs. The dashed lines delimit the boundaries of typical *virgata,* typical *purpurescens,* and typical tenuispica from Figure 1. The OTUs are assigned to *virgata* (V), *purpurescens* (P), or *tenuispica* (T) by the SDA. OTUs linked by a solid line are incongruous pairs.

incongruous pairs involving *virgata* and *tenuispica* (6 pairs) than *virgata-purpurescens* or *purpurescens-tenuispica* (4 pairs each).

No consistent combination of features serves to distinguish the taxa. The spikelet variability within a single plant, represented by conformity to one of the typical groups, was just as great for some specimens as the variability between taxa. The incongruous pairs in particular had atypical combinations, such as inverse glumes with strongly contorted awns on the same spikelet, or one spikelet typical of *virgata* and one spikelet typical of *purpurescens* within the same panicle. Although material typical of each taxon is common, morphologic intermediates are certainly not rare, and represent a significant phenetic shuffling of features. Clearly, only one morphologic taxon is present here. The original three entities may deserve recognition at the infraspecific level, but even this is questioned by the presence of incongruous pairs within the same panicle. At this point nothing is known about the chromosome numbers for these taxa or about the reproductive mechanism. Final disposition of the taxa must await these further investigations.

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